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ESSAY

INFORMATION TECHNOLOGY PORTFOLIO MANAGEMENT AND THE REAL OPTIONS METHOD (ROM): MANAGING THE RISKS OF IT INVESTMENTS IN THE DEPARTMENT OF THE NAVY (DON)

by

Jeffery P. Davis

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Thesis Advisors:	Philip Candreva
	Kenneth Doerr
Second Reader:	Glenn Cook

I. INTRODUCTION

A. BACKGROUND

The FY 2003 Federal Budget contains provisions for over $52 billion in IT investments (Federal CIO Council 2002). The Navy portion of those funds is over $5 billion. One of the most difficult issues facing the DON is determining how these funds should be used and evaluating the validity of current IT investments. Rapid change and increasing uncertainty in the technology field has resulted in a high degree of financial risk associated with IT capital investment. Addressing this risk has become more important as the cost of IT investment continues to rise and financial resources become more constrained.

The problems DON faces with regard to selecting, managing, and evaluating IT solutions are common to all government agencies. The potential for waste caused by these shortcomings has attracted the attention of Congress. In response to these concerns, Congress passed the Paperwork Reduction Act of 1995, which requires that all government agencies define program information needs, develop an information resources management (IRM) plan, and integrate the IRM within the organization. This plan was to be "integrated with organizational planning, budget, financial management, human resources management, and program decisions" (DON 2001a). The Clinger-Cohen Act of 1996 further shifted the momentum in government towards identifying a systematic mechanism for selection, management, and evaluating IT solutions.

B. IT PORTFOLIO MANAGEMENT

The government, and DON specifically, has looked to the commercial sector to identify a model for making IT investment decisions, implementing IT solutions, and evaluating the return on investment. The Federal Chief Information Officer (CIO) has since identified ITPM as the mechanism by which IT investments are selected, managed, and evaluated. The Federal CIO has defined ITPM as a system for evaluating, selecting, prioritizing, budgeting, and planning for investments that provide the greatest value/contribution to an organization (Federal CIO Council 2002). **Figure 1** provides a

graphical representation of the three-phase ITPM process and how it is linked to the PPBES (DON 1999).

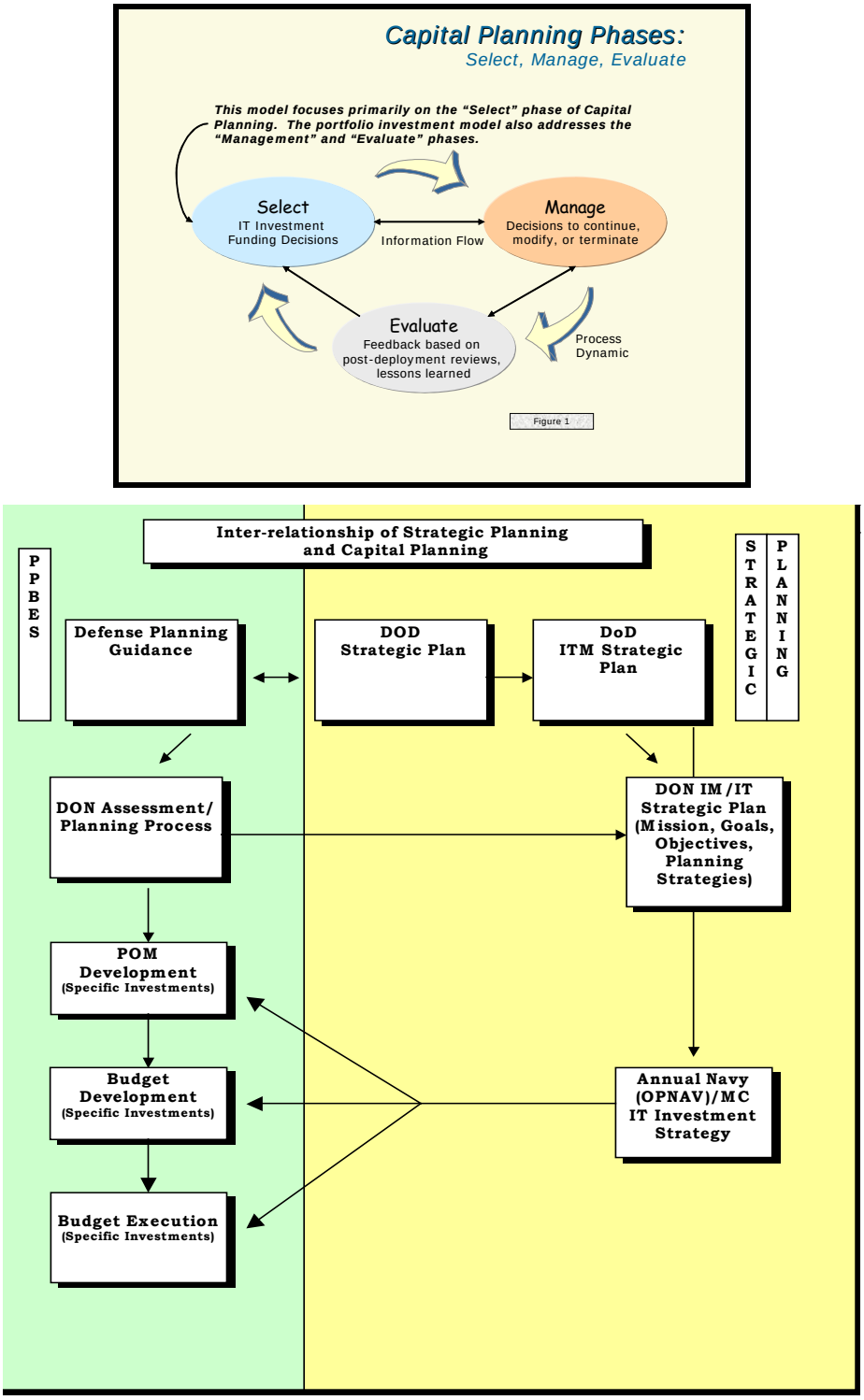


Figure 1. Capital Planning Phases and PPBES.

Many DON organizations are now actively employing ITPM for IT investment decisions. Still, these organizations must address the issue of managing the financial risks inherent to IT investment that may not be adequately addressed through commonly used tools such as discounted cash flow analysis (DCF), decision tree analysis, and net present value (NPV). The Real Options Method (ROM) is a tool cuhistorically used in financial markets for managing risk. In recent years, it has gained prominence as a method of managing capital investment risk in areas such as pharmaceutical R&D, petroleum exploration, and energy trading (Boer 2002). Since ITPM is based on Modern Portfolio Theory derived from the capital markets, ROM shows promise as a tool for managing IT investment risk. Analysis of the benefits and limitations of utilizing ROM with ITPM is an important step in gaining insight into how to make better IT investment decisions and effectively manage the risk involved in committing limited DON financial and human resources. The success of ROM in the arena of IT investments can provide far-reaching benefits to managers attempting to balance the risks of IT investments with the competing demands on scarce financial and human resources. This essay seeks to address these concerns by identifying the usefulness of ROM in addressing IT investment risks within the framework of ITPM.

The viability of ROM as a risk management tool in government may be far reaching. In fact, a recent article by Commander Greg Glaros of the Office of Force Transformation offered ROM as a possible tool for evaluating new DOD programs within the framework of the PPBES. However, the major issue that is faced when dealing with projects in government is related to purpose, time, and amount (PTA) restrictions. Projects are defined and funded based on available funding. The established funding (amount) can only be used for the intended purposes set forth in the appropriation (purpose) and is only available for the duration of that appropriation (time). Although PTA restrictions present a challenge, ROM provides a financial tool that can evaluate multiple strategic pathways present in the changing global landscape. If ROM is demonstrated to be a viable method of managing IT investment risks, this method can be applied to IT and other strategic investments across DON and other government agencies in the foreseeable future.

II. THE ROM-ITPM FRAMEWORK

A. ROM AND UNCERTAINTY

Inherent in all business decisions is a careful balancing of risk versus reward. Most managers view the uncertainty that exists in strategic investment decisions as something to avoid, but they understand that higher risk is also associated with higher reward. Over the past several decades, managers have looked to different tools to help them make critical investment decisions that often meant the difference between sustaining/achieving competitive advantage and becoming irrelevant. Discounted Cash Flow (DCF), Net Present Value (NPV), and decision tree analysis have been the traditional methods for evaluating these investment decisions. Each of these measures provides important information that allows managers to make comparisons among competing investment choices. Unfortunately, these methods fail to account for the iterative nature of "real world" decisions. These methods treat investment decisions as a static process assuming away management's ability to alter decisions as conditions change. This hardly reflects the true complexity of IT capital investment decisions. In reality, every capital investment decision is based on a series of options. Managers can elect to "defer additional work, abandon it outright, shut it down and restart later, expand it, trim it back, or even switch its strategic purpose" (Alleman 2000). ROM provides a framework to address this "real world" scenario.

1. What is a Real Option?

A real option, similar to a financial option, can be defined as "the right, but not the obligation, to take an action in the future" (Amran and Kulatilaka 1999). The major difference is that real options apply financial option theory to options on non-financial (real) assets. A real option allows the owner to invest (call) in an asset or project at a given price within an established period of time. The key is that there is no obligation to actually invest. If the option is never exercised, the owner of the option loses only the cost of the option, yet the potential for gain remains high. It stands to reason that the owner of the option will only choose to exercise the option to invest in an asset or project when conditions are favorable. Therefore the greater the uncertainty associated with an

option, the greater the value of that option. The following are terms associated with options that are also common to Real Options (Mun 2002).

> **Option (Real Option)** - a contract that gives the owner the right but not the legal obligation to buy or sell an underlying asset (invest in a project/asset).
>
> **Call** - an option to buy (invest in) a specified number of shares (specified project) at a pre-established price within some future period.
>
> **Exercise price (Strike price)** - the price stated in the option contract at which the security (project/asset) can be bought or sold.
>
> **Market price** - the value of the underlying security (project) in the market.
>
> **Option price (Call price)** - the market price for the option contract.
>
> **Expiration date** - the date the option expires or matures.

Options effectively restrict downside risk due to uncertainty while retaining the potential for upside (good) risk. **Figure 2** depicts this characteristic of options (Devaraj and Kohli 2002). Here we see that the option is exercised only when the market price (M) is favorable and reaches the exercise price (X). As the market price increases, the payoff increases as illustrated by the 45-degree line following the exercise price. The graph on the right illustrates that the profit available from exercising the option is slightly reduced by the amount paid for the option referred to as the call price (-C). As previously discussed, this cost also represents the limit on loss achieved by buying the option.

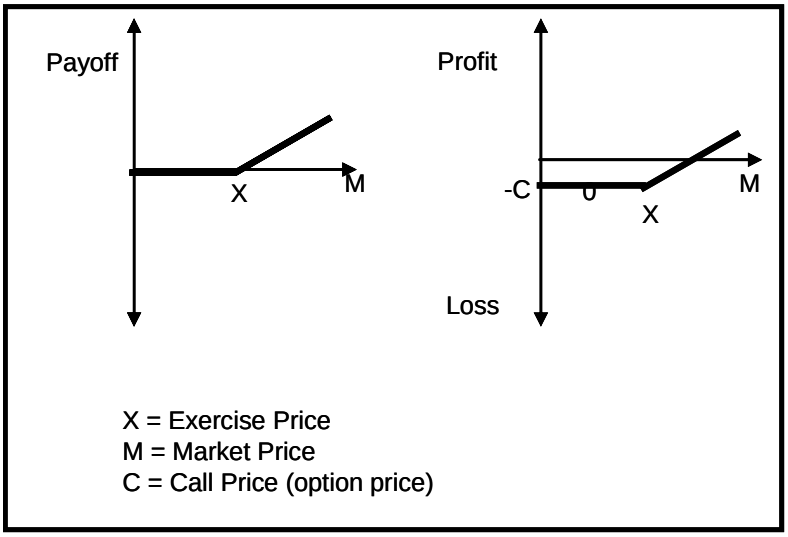


Figure 2. Call Option Impact on the Owner.

Real Options provide a valuable tool for "identification, valuation, prioritization, and selection of strategic projects" (Mun 2002). The Real Options Method can provide answers to important questions and facilitate better decisions by helping managers to effectively identify and evaluate alternatives. Specifically, ROM is useful in:

- Identifying different strategic investment decision pathways.
- Valuing each strategic decision pathway and its financial viability and feasibility.
- Prioritizing these pathways/projects based on qualitative and quantitative metrics.
- Optimizing the value of strategic investment decisions by evaluating different decision paths.
- Timing the effective execution of investments and finding the optimal trigger values and cost of revenue drivers.
- Managing existing or developing new optionalities and strategic decision pathways for future opportunities (Mun 2002).

B. ADDRESSING RISK WITH ROM

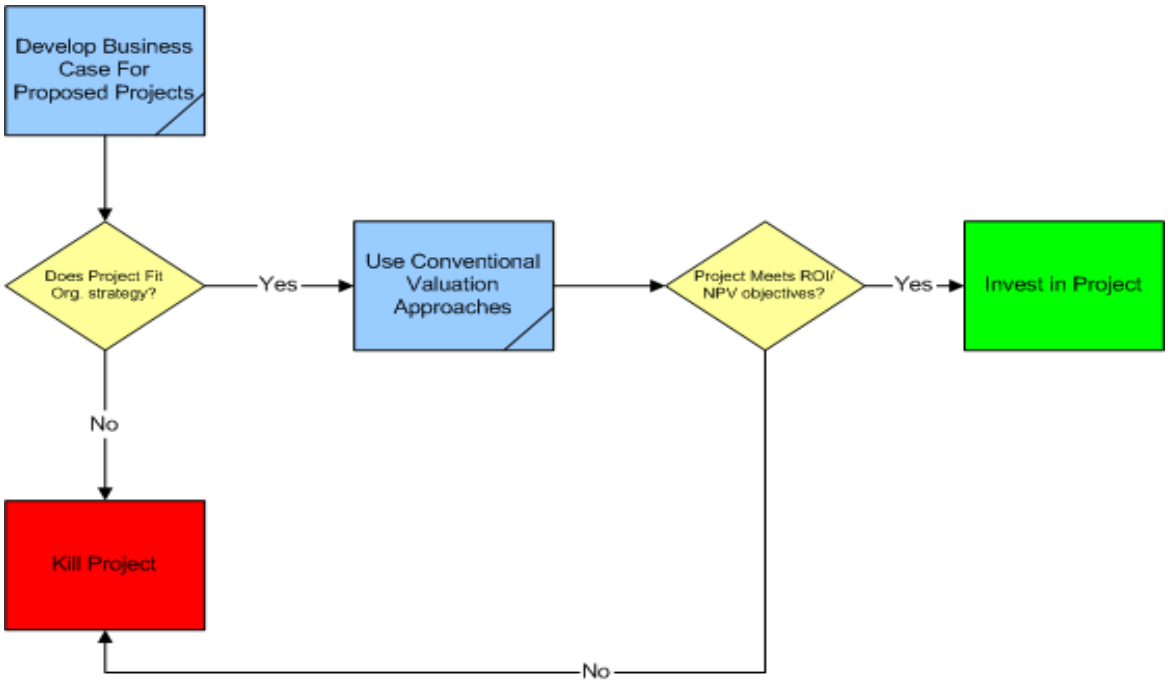
Managers recognize that strategic investments are often made in uncertain environments, which leads to financial risk. Strategic investments in government, including information technology investments, fall into this category. ROM is a tool that allows managers to use options techniques to minimize these financial risks. We begin our discussion by defining risk.

1. Risk

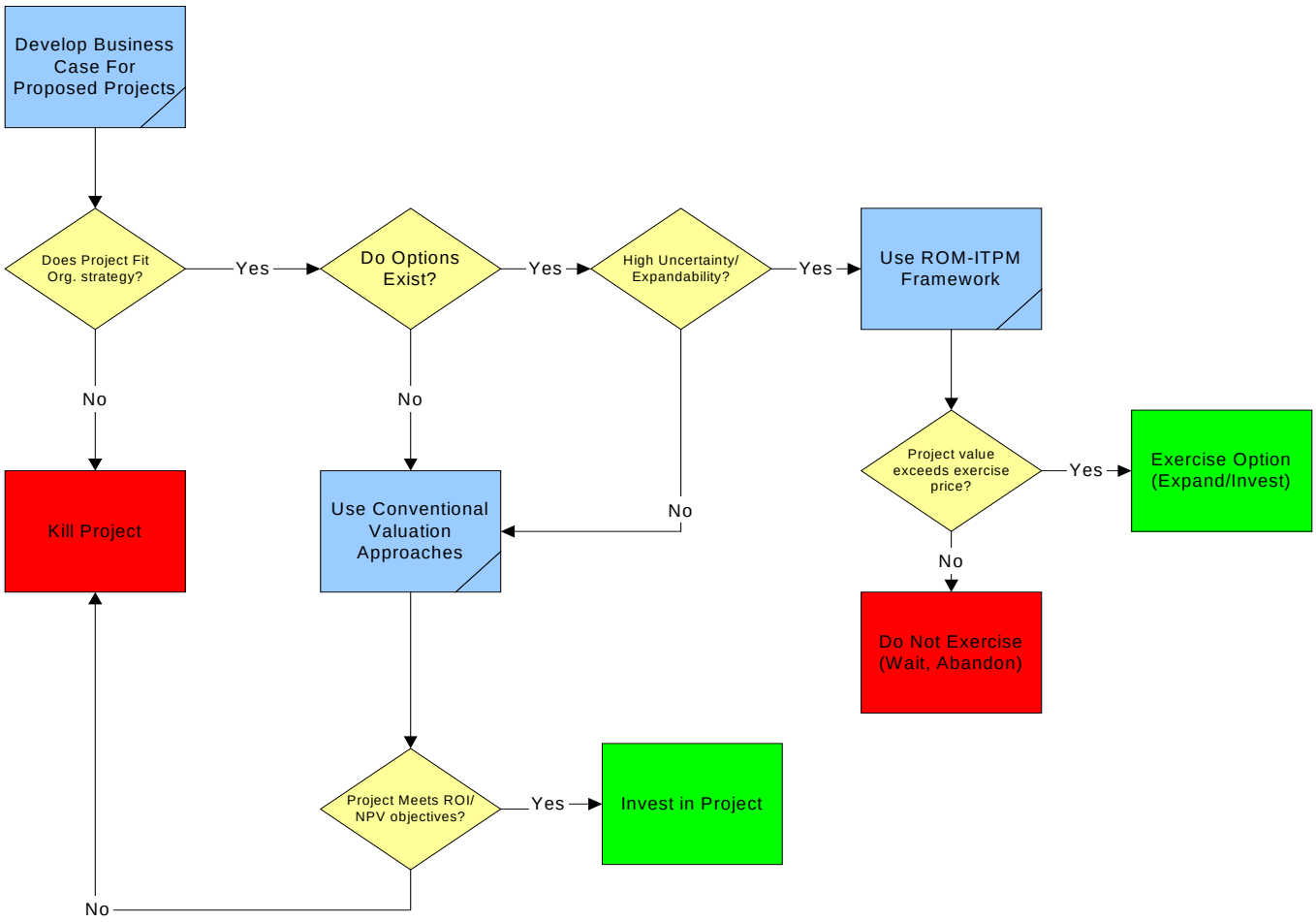
A typical dictionary defines risk as the possibility of suffering harm or loss. A more academic description of the term identifies risk as a combination of the probability of an event occurring and the severity or magnitude of that event (Liao 2002). When relating this idea to IT investments, risk can be thought of as the possibility that if something goes wrong with the project, the organization may not be able to realize the projected value that justified the project in the first place. This simple realization drives prudent managers to dedicate significant resources to identifying, measuring, and mitigating risks. The extensive discussion of risk in portfolio management and capital investment literature underscores the importance being placed on managing risk. There are two major types of risk: unique (private) risk and systematic (market) risk (Boer

2002a). Unique risks can be thought of as those risks that are inherent to a particular organization and are partially subject to the organization's control. These are the types of risks that have been a focus of the current implementations of ITPM. As one might suspect, higher unique risk results in lower project value. Conversely, systematic risks are based on volatility that organizations cannot control. This category of risks is where ROM offers significant potential. ROM leverages the uncertainty that permeates systematic risks to identify opportunities and create value. Most projects have aspects of both of these types of risks. Current implementations of ITPM neglect this fact and therefore cause managers to overlook opportunities that appear unattractive due to limitations present in current tools such as NPV and decision tree analysis.

The ROM-ITPM methodology advocated by this essay attempts to identify situations when uncertainty of cash flows (or savings) exists and there is flexibility regarding the investment decision (alternative options). **Figure 3a** is a logical diagram that illustrates how investment decisions are made using only traditional discounted cash flow models. Once again, this logical process fails to capture the dynamic nature of investment decisions. **Figure 3b** is a logical diagram of how the proposed ROM-ITPM may be incorporated to provide additional insights into investment decisions.



a. Logical Diagram of the Current Investment Decision Process.



b. Diagram Incorporating the Proposed ROM-ITPM Methodology

Figure 3. ROM-ITPM Methodology.

This modified logical diagram provides a disciplined approach to making investment decisions needed to provide additional insights necessary for better investment decisions. The remainder of this essay is dedicated to defining the three-step process of the ROM-ITPM methodology and the important information this new methodology can provide.

2. Steps for Using ROM to Evaluate a Project

Using ROM to evaluate a project can be accomplished through a series of steps which include framing the option, analyzing the option, and acting or exercising the option. Intuitively, most DON managers evaluate options every day. They begin with a subjective assessment of the probability of risk event associated with a decision and

attempt to ascertain whether the potential benefits outweigh the potential costs. Managers do this because they understand that they can little afford to ignore the fact that the value of a long-term project may change over time due to rapid advancements in technology, shifting requirements and changing threats. ROM provides a mechanism to quantify this sort of management intuition. As resources become increasingly constrained, it will become even more important for managers to be able to effectively quantify the value of alternatives to facilitate intelligent comparisons and sound investment decisions.

ROM is not a "one size fits all" solution. In fact, there are times when ROM is not recommended. For instance, projects with cash flows, costs, and effectiveness that are known or predictable with a high degree of certainty do not require the added rigor of ROM. Also, in cases where mandates exist for how, when, and what to invest in, ROM is of little use. In such cases, where little uncertainty exists or when no options exist, the traditional methods for making investments are suitable. ROM should be used when any of the following situations exist:

- There is a contingent investment decision.
- Uncertainty is large enough to make it worthwhile to wait for more information.
- Value may be captured in possibilities for future growth options.
- Uncertainty is large enough to make flexibility a consideration.
- When there will be project updates and mid-course strategy corrections (Amran and Kulatilaka 1999).

a. Framing the Option

Framing can be thought of in terms of identifying and defining an opportunity. It is accomplished by dividing the path to the objective into separate stages. For instance, a large project with a large amount of uncertainty can be separated into a series of smaller pilot projects. This allows the organization to test the risks of the project at a reduced cost before expanding the project. **Figure 4** is an example of the type of strategic tree that may be used to frame options.

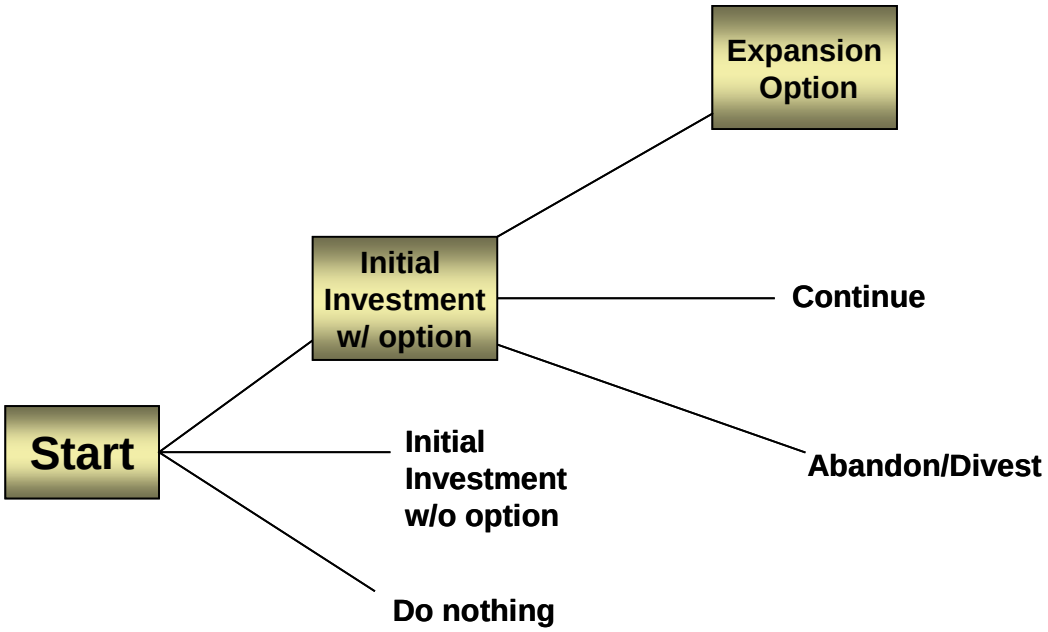


Figure 4. Strategic Tree Example.

Framing the option also involves developing a business case and assessing the risks involved. Developing the business case and assessing risks are already integral parts of ITPM. Although this process typically occurs in the initial stages of ITPM it is also a critical part of the ROM-ITPM methodology that deserves mention. The business case must establish the costs and value-creating elements of the proposed project in the form of cost-savings/cost avoidances, or improved capabilities. When establishing the business case the organization evaluates whether the proposed investment fits its current strategy. Organizations often hurt themselves by simultaneously embarking on numerous uncoordinated projects, betting their company's future on one major project, or simply following the crowd investing in "the next big thing." This essay incorporates the use of portfolio maps as a simple heuristic tool that can aid DON leaders in evaluating business cases within the proposed ROM-ITPM framework.

Managers must ensure that IT investments are evaluated for business viability and business fit. The viability of a project is based on quantitative data about an investment's likely payoff. Conversely, fit is a qualitative assessment that attempts to measure how well an investment matches the organization's existing processes, capabilities, and culture (Tjan, 2001). The portfolio map illustrated in **Figure 5** provides

a tool for evaluating investment strategies based on the degree of viability and fit of a project (Tjan 2001). For instance, managers may make the assessment that although a project is sound and will produce tangible benefits it is not a core capability of the organization. In such cases, the project can be described as having a high degree of viability but a low degree of fit. The portfolio map illustrates that such a project should be re-assigned or outsourced. By outsourcing this project the organization can use its resources (personnel and time) to concentrate on core areas. These types of decisions have become increasingly important in DOD as the demands on our limited military forces have continued to expand.

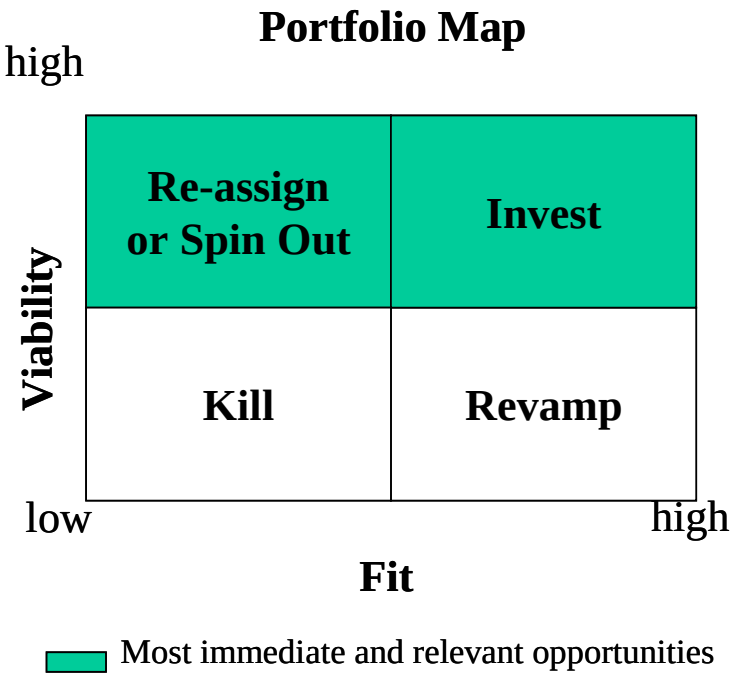


Figure 5. ROM-ITPM Portfolio Map.

The proposed ROM-ITPM methodology advocated by this essay incorporates an assessment of strategic fit and viability. The attention given to these two important aspects of a proposed investment ensures that proposals not worthy of management attention are weeded out early.

b. Analyzing the Option

Analyzing options involves the application of options algorithms. Options algorithms can be accomplished using Monte Carlo path-dependent simulation methods,

binomial lattices, and closed-form equations such as the risk-neutral Black-Scholes model. Binomial lattices and derivations of the Nobel prize-winning Black-Scholes formula are the most commonly used of these techniques. The ROM-ITPM methodology advocated in this essay incorporates the mathematical discipline of the Black-Scholes formula and the flexibility of binomial lattices.

The Crystal Reports© Real Options software incorporates both Black-Scholes and binomial lattices into a single graphical display based on common inputs: (1) value of the underlying asset -**V**, (2) exercise price -**X**, (3) time to expiration -**T**, (4) risk-free rate -**r**, and (5) volatility (uncertainty) -σ.[1]

The information obtained from this analysis goes beyond the static discounted cash flow analysis. Best and worst case scenarios are identified to help managers determine their degree of exposure to financial risk. However, it is important to note that the proposed ROM-ITPM methodology and the neatly packaged solution obtained through software should not be viewed as the silver bullet that provides the definitive solution. Instead, the value of the ROM-ITPM process lies in the disciplined approach that causes managers to view investments as options, which reflects the true nature of most investment decisions. The added benefit is a solution that provides best/worst case scenarios for a project or initiative that allows the manager to estimate how much they should be willing to spend on pilot tests, know when it makes economic sense to expand a project, and know the cost of waiting. **Figure 6** is an example of the output obtained that can be used to value the different strategies. This additional information provided by the proposed ROM-ITPM methodology gives decision-makers the tools to make better decisions while minimizing financial risk in situations where considerable uncertainty exists. Combining the structure of strategic trees with the analytic discipline of Black-Scholes and lattices provides the decision-maker with a powerful tool for assessing investments that contain considerable risk and uncertainty.

[1] Detailed discussion of Black-Scholes and binomial lattice techniques are beyond the scope of this essay. More information regarding the use of these techniques can be found in Johnathan Mun's *Real Options Analysis* (2002), and other financial/economics texts.

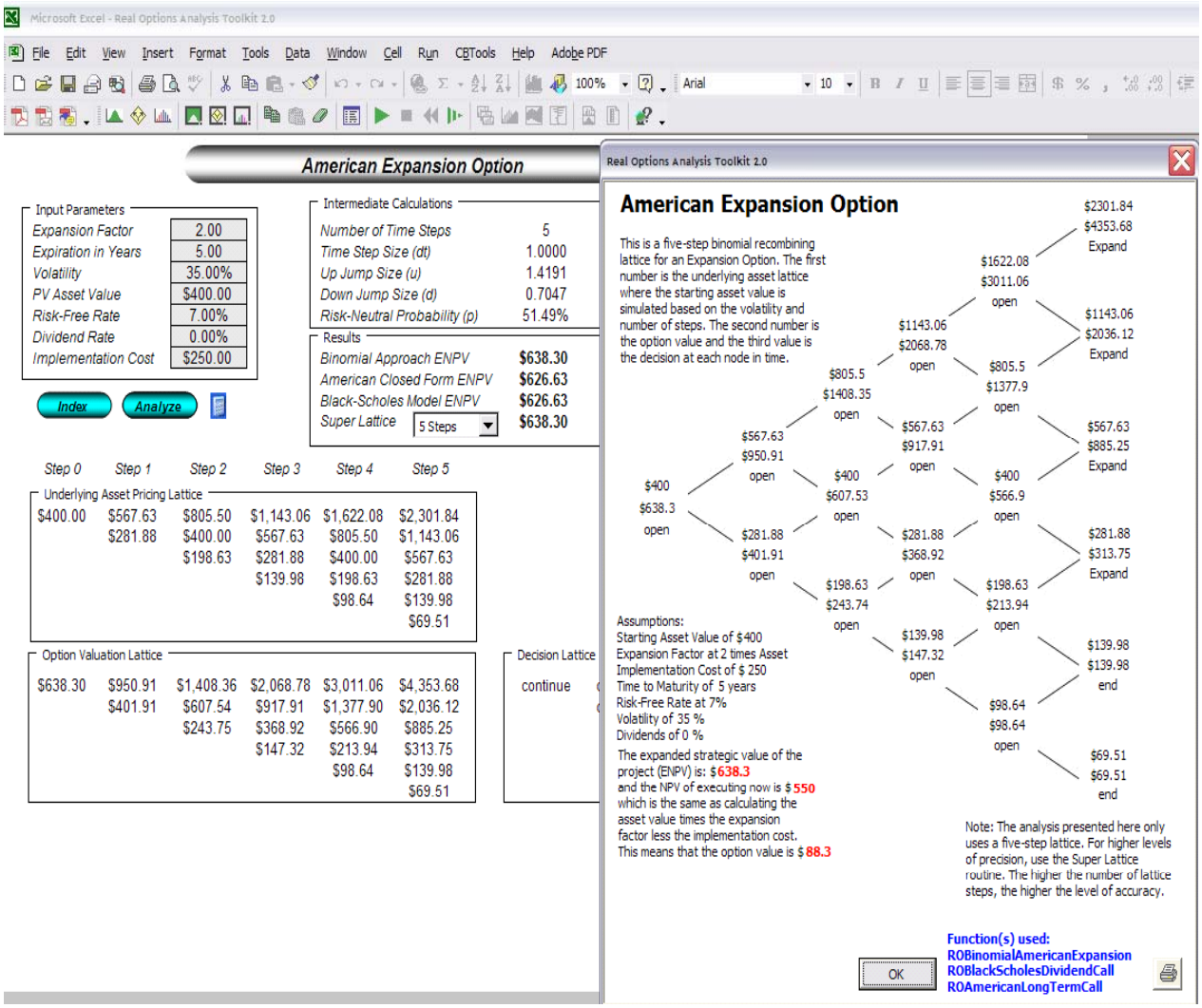


Figure 6. Output from Crystal Reports© Real Options Software.

c. Acting on the Option

Acting or exercising the option is the final step in this three-step process. As discussed previously an option gives its owner the right to take an action in the future without obligating the owner to exercise that option if conditions are unfavorable. It stands to reason that in ROM, the option is only exercised when the value derived by exercising the option is deemed sufficient to warrant exercising the option. Therefore, exercising the real option consists of the decision to pursue a project by signing a contract or purchase agreement. The project phases identified in step one of this three-step process allow managers to view each stage as the purchase of an option to pursue the next stage of a project. This important aspect of this process gives the organization an

opportunity to learn more about the risks involved in a project before moving ahead into a progressively larger (more expensive) stage. By using ROM in ITPM the organization can make better investment decisions and utilize the flexibility of options to avoid missing important opportunities.

This essay offers a structured approach for determining when the ROM-ITPM methodology should be used. The logical diagram provided in Figure 3b is designed to aid managers in deciding when to employ the ROM-ITPM methodology. **Figure 7** illustrates the proposed ROM-ITPM process advocated in this essay. This ROM-ITPM process begins in the ITPM select, manage, and evaluate cycle. Managers can then use the portfolio map to evaluate proposed projects for viability and fit. This stage involves a review of the project's business case including discounted cash flow analysis. The initial option framing step takes place when a strategic tree is developed to identify possible strategies for executing the project incorporating options (pilot tests, advanced procurements of features/capabilities, etc.). Once potential strategies are identified the analyzing step begins as options are analyzed using Crystal Reports© Real Options software to simulate discounted cash flows and calculate option values. In the final step, managers are able to act on the option by utilizing the outputs obtained from the ROM-ITPM methodology to compare competing projects, optimize a portfolio of investments, or make new (or expansion) investment decisions.

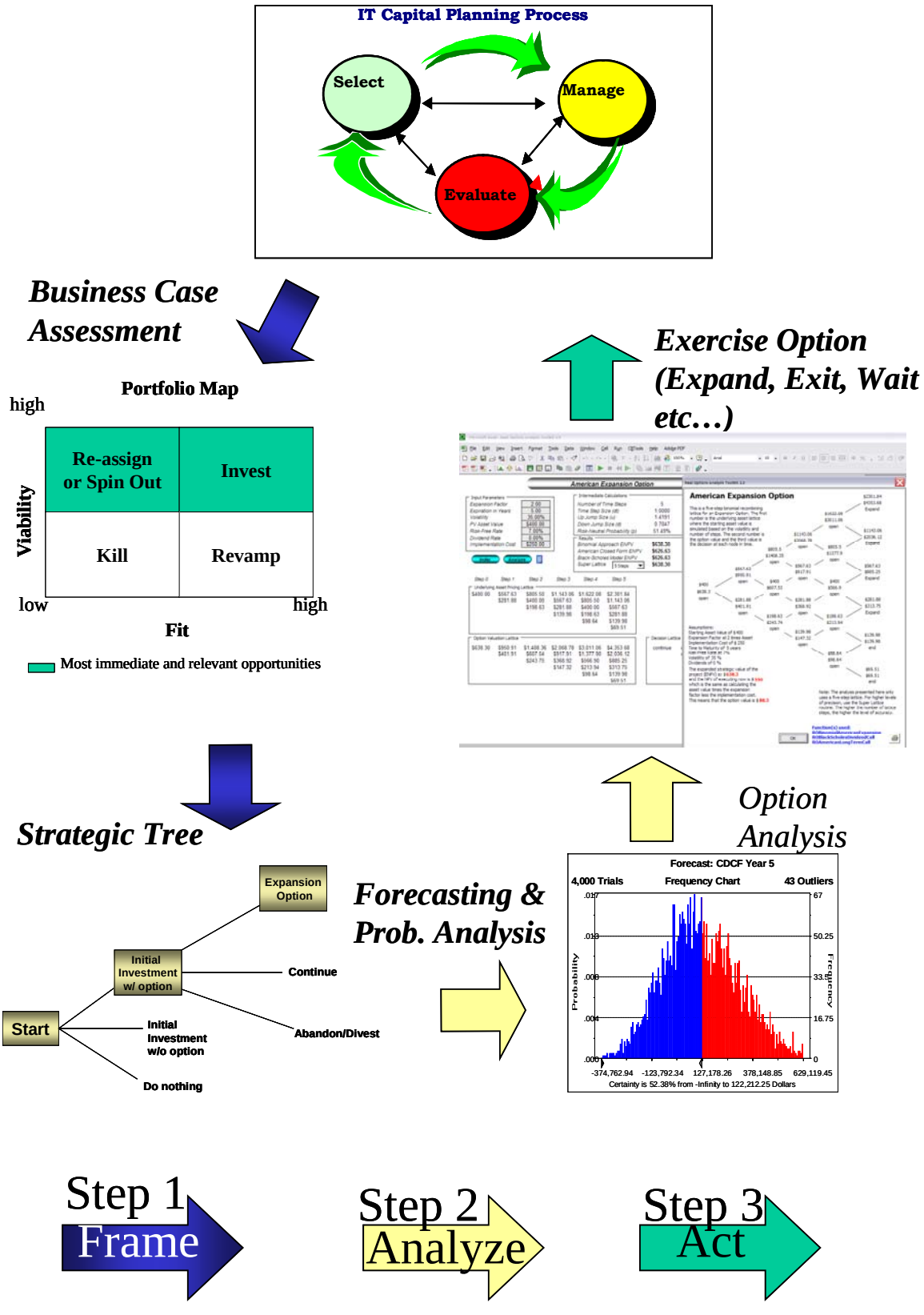


Figure 7. ROM-ITPM Methodology.

III. SUMMARY

A. RESULTS …A MODEL FOR ADDRESSING RISK

Tools such as the DCF methods commonly used to evaluate investments are extremely useful in analyzing investments provided the assumptions regarding cash flows (or cost savings) hold true. Such tools provide important information, but they fail to account for the iterative nature of real world decisions. These methods treat investment decisions as a static process and do not reflect management's ability to alter decisions as conditions change.

The ROM-ITPM methodology has been introduced as an additional tool for evaluating IT investments. This methodology is intended for use in circumstances when the decision-maker has flexibility regarding what, when, and how an investment is made. The logical diagram provided in Chapter III, Figure 3(b) has been presented as a tool for determining when the ROM-ITPM methodology should be used. Again, the ROM-ITPM methodology is presented as a supplement to existing tools for evaluating investments, but not as a replacement. It is one more tool for managers to use when evaluating investment opportunities. ROM uses rigorous option theory analytics to derive the value of investment alternatives based on determining the level of uncertainty associated with predicted cash flows.

The mathematical discipline of this approach helps to place a value on the uncertainty commonly associated with strategic investments. However, the real benefit of this approach is that it allows decision-makers to identify investments as options, which reflects the true nature of most investment decisions and what most managers do intuitively, but here with rigor and precision. The solutions obtained provide best/worst case scenarios and allow the manager to estimate the maximum that should be spent on pilot tests, know when it makes economic sense to contract, expand, abandon, change, and wait given the circumstances surrounding a project.

B. BROADER IMPLICATIONS

This essay has identified how the Real Options Method can be utilized as a tool to manage the risks associated with investments in the rapidly changing world of

technology. As we have discussed, this method is already widely used in the private sector to manage the financial risk and uncertainty of capital investment decisions. The disciplined approach to evaluating investments offered by ROM is not only useful for IT investments but also for other investments that involve committing resources when there is considerable uncertainty regarding outcomes (returns on investment). This is an apt description of most of the investments that are made within the Department of Defense (DOD). As discussed earlier, the Office of Force Transformation has already offered the Real Options Method as a possible mechanism for evaluating new DOD programs. A recent Office of Force Transformation article asserts that "leaders of the military services now confront the dilemma of whether or not to invest in a particular stage of a new program or, given market and technology uncertainties surrounding the perceived need, delay the decisions" (Glaros 2003).

In spite of the PTA restrictions already mentioned, the ROM-ITPM methodology can still provide important information for deciding which programs should be funded based on fit and how the program should be pursued (in-house vs. outsourcing). The flexibility required to deal with a rapidly changing global landscape will require efforts to increase the flexibility of the existing PPBES process to give managers of major programs greater flexibility to take advantage of investment opportunities by shifting resources. Today, this flexibility is being incorporated into our acquisitions process through spiral acquisition and project development techniques. The ROM-ITPM is a good fit to facilitate these techniques by providing a financial tool that can evaluate multiple strategic pathways. As economic resources become more and more constrained it will be important to explore new methodologies like ROM to sustain competitive advantage in a rapidly changing world. This fact is as much a reality for DOD as it is for the commercial sector.

C. CONCLUSION AND RECOMMENDATION

This essay has identified ROM as an additional tool to be used in evaluating strategic investments that involve uncertainty. The ROM-ITPM approach advocated by this essay provides a disciplined approach to evaluating these investments without significantly expanding information requirements and administrative burden. The same information currently used for business case analyses can be applied to the ROM-ITPM

framework to obtain additional insights helpful in making sound strategic investment decisions. Therefore, the discipline of the ROM-ITPM approach can be applied without dramatic changes in the current strategic investment decision-making processes. Appendix I briefly describes how interested organizations can apply the ROM-ITPM approach to their current processes.

Based on the results of this study, it is recommended that the ROM-ITPM methodology be adopted by the Navy eBusiness Operations Office to support its screening process for Navy pilot projects. This methodology will assist in the determination of which pilot projects to fund, and to what extent they should be funded. It is also recommended that the DOD Force Transformation Office continue its efforts in developing mechanisms to apply ROM to the PPBES in order to improve investment flexibility and reduce financial risks associated with these investments.

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